Descriptions of the Level IV Ecoregions of Montana

Second Edition

15. Northern Rockies

The Grave Creek Range-Nine Mile Divide ecoregion is composed of northwestsoutheast trending, forested mountains that are partially mantled by volcanic ash and underlain by Precambrian argillite, argillaceous rocks, and quartzite. It is more rugged than the Salish Mountains (151) and has a different topographic orientation than either the wetter Clark Fork Valley and Mountains (15k) or the lithologically distinct Glaciated Bitterroot Mountains and Canyons (16e). Elevations range from about 3,200 to just over 6,500 feet and the average precipitation ranges from about 25 to just over 65 inches per year; maximums are much less than in the St. Joe Schist-Gneiss Zone (15p) to the west. Climax vegetation is mapped as subalpine fir, Douglas-fir, grand fir and ponderosa pine forests and is different than that of the neighboring Clark Fork Valley and Mountains (15k) and Bitterroot-Frenchtown Valley (17s). Logging, mining, and recreation are the common land uses.

The treeless Camas Valley ecoregion is largely underlain by Quaternary lacustrine deposits. It is in the rainshadow of the Salish Mountains. The average annual precipitation is 12 to 16 inches and maximums are lower than those of the nearby Flathead Valley (15c). Flowing springs, hot springs, wetlands, accumulations of alkali salts, and sodiumaffected soils occur locally and huge ripple marks are found in the Camas Prairie Basin. Stream density is low and much of the aquatic biota is different from surrounding ecoregions. The potential natural vegetation is foothills prairie which is distinct from the subalpine fir, Douglasfir, grand fir, and ponderosa pine forests of the nearby Flathead Hills and Mountains (15e). Sagebrush has largely replaced bunch grass and is now common. Grazing is the prevalent land use. The land use mosaic contrasts with that of Ecoregion 15c.

The broad, intermontane **Flathead Valley** ecoregion is largely treeless. It lies west of the Canadian Rockies (41), contains Flathead Lake, and is underlain by Quaternary glacial outwash, till, lake sediments, and alluvium. Considerable climatic diversity occurs within the valley; the north experiences frequent outbreaks of arctic air during the winter, near shore areas are lake-moderated, and low-lying areas can be cold. The average growing season approaches 150 days in the most favorable sites and can be less than 90 days in the least favorable sites. Average annual precipitation ranges from about 14 to just over 25 inches. Typically, the eastern and northern areas receive the most rainfall, and maximums exceed those of the Camas Valley (15b). Potential natural vegetation is mostly foothills prairie and is distinct from the forests of the Northern Rockies (15) and Western Canadian Rockies (41c). Local land use is affected by microclimate. Unirrigated-irrigated agriculture, rural residential, suburban, and commercial activity dominates the region and orchards are found in especially mild locations. Alkali accumulation has occurred locally as a result of irrigation.

The treeless **Tobacco Plains** ecoregion lies to the west of the Canadian Rockies (41) in the Rocky Mountain Trench at an elevation of 2,600 to 4,000 feet. The ecoregion is covered by Quaternary drift, lacustrine, and alluvial deposits. It contains lakes and the only extensive drumlin field in Montana. The Tobacco Plains (15d) is physiographically distinct from the higher and more rugged Western Canadian Rockies (41c) and Salish Mountains (15l). Xeric and Frigid Haploxerolls, Haploborolls, Xeropsamments, and Xerochrepts are common; these soils are rare in the surrounding, mountainous ecoregions. Climax vegetation is foothill grassland and contrasts with the subalpine fir, Douglas-fir, grand fir, and Engelmann spruce forests of Ecoregions 151 and 41c. Lumber mills, sand and gravel operations, grazing, and residential-commercial activity occur; the land use mosaic is distinct from that of Ecoregions 151, 15t, and 41c which are dominated by logging and forest recreation.

The semiarid to subhumid Flathead Hills and Mountains ecoregion is underlain by Precambrian argillite, argillaceous rocks, and quartzites. It is in the rainshadow of the Salish Mountains. Average annual precipitation ranges from 16 to just over 25 inches and is less than that received by the higher Grave Creek Range-Nine Mile Divide (15a) and Salish Mountains (151) to the west. Climax vegetation is mapped as subalpine fir, Douglas-fir, grand fir, and ponderosa pine forests and the tree cover is commonly sparser than in wetter ecoregions.

15h The wet, glaciated mountains of the High Northern Rockies ecoregion are underlain by mixed rock types. It is differentiated from lower ecoregions by its characteristic rockland, talus, and/or mixed high elevation climax vegetation. It is similar to the High Idaho Batholith (16h), Alpine Zone (17h), and the Crestal Alpine-Subalpine Zone (41b) that occur in different level III ecoregions. Above treeline, tundra, alpine grassland, subirrigated meadows, and wetlands are found. At or just below treeline, subalpine parkland and

open, wind-blown stands of nonmarketable subalpine fir, Engelmann spruce, and whitebark pine occur. Subalpine fir, whitebark pine, mountain hemlock, and alpine larch forests are found in glacial cirques. Elevations range from about 6,000 to just over 10,600 feet and are sufficient to trap large amounts of Pacific moisture. Average annual precipitation is commonly 60 to 100 inches. The soils are often gravelly to stony and, especially in the northwest, andic.

The rugged, wet, forested Clark Fork Valley and Mountains ecoregion is affected by moist maritime air masses, and is commonly underlain by Precambrian quartzite, argillite, and argillaceous rock. Characteristically, it is more rugged than the lower Salish Mountains (151), lithologically distinct from Idaho Batholith (16), has a different topographic orientation than the drier, southeasterly trending Grave Creek Range-Nine Mile Divide (15a), and was not glaciated by continental ice sheets unlike the more northerly Purcell-Cabinet-North Bitterroot Mountains (15q). Soils are often deep and derived from volcanic ash which increases the fertility and water holding capacity of the soil. Ash is a more common soil constituent in Ecoregion 15k than in further south in Ecoregion 16e. Ecoregion 15k experiences much more maritime influence than more easterly and southerly ecoregions. Pacific air masses increase both cloudiness and precipitation. Average annual maximum precipitation can exceed 100 inches, which is characteristically much greater than that of neighboring, more easterly ecoregions. Climax vegetation is mapped as subalpine fir, grand fir, and Douglas-fir forests; Engelmann spruce and Pacific species such as western redcedar and western hemlock also occur. Land uses include intensive logging and recreation.

The **Salish Mountains** ecoregion is forested and underlain by Precambrian Belt rocks. Its volcanic ash-mantled crests rarely exceed an elevation of 7,000 feet and lack the alpine zones that occur in higher mountains. Average precipitation is about 20 to 50 inches per year and is markedly lower than that of the Purcell-Cabinet-North Bitterroot Mountains (15q) and the Canadian Rockies (41). Ecoregion 151's northern portion receives more precipitation than the southern; it was glaciated by the Cordilleran ice sheet which modified physiography and deposited till. Till deposits influence slope hydrology and perennial streams are, therefore, more numerous in the glaciated north than in the unglaciated south. Extensive logging and recreation are the common land uses. Ecoregion 15l extends into Canada.

The mountainous, forested Coeur d'Alene Metasedimentary Zone is mantled by thick volcanic ash and underlain by fractured quartzite and argillaceous rock. It is lithologically unlike Ecoregions 15i and 15p. Pacific influence is stronger than to the south and Douglas-fir, grand fir, western redcedar, and western hemlock occur. Acid drainage from mine tailings and historic mining practices have left some streams nearly devoid of aquatic life. Smelter emissions have denuded hillslopes. Massive restoration efforts are now underway.

15n The St. Joe Schist-Gneiss Zone is mountainous, mantled by ash, and lithologically unlike the granitics of Ecoregion 16. Rocks are more weathered and slopes are more unstable than in Ecoregion 15o. High gradient streams dissect the region and receive episodic sedimentation from landslips. Pacific influence is greater than to the south and is sufficient to support a potential natural vegetation of cedar- hemlock-white pine forest. Nineteenth century logging practices removed most of the valuable western white pine and altered forest composition.

The Purcell-Cabinet-North Bitterroot Mountains ecoregion is mantled by volcanic ash and underlain by quartzite and argillaceous rocks. Slopes are more stable and there is less stream sedimentation after disturbance than in nearby granitic and schistic areas; related management issues are also different. Drift deposits occur but continental ice did not extend further south into the Clark Fork Valley and Mountains (15k). Cedar-hemlock-pine forest and, at higher elevations, western spruce fir forest occur. Western hemlock is more widespread and marine influence is stronger than in Ecoregion 16.

The long Stillwater-Swan Wooded Valley ecoregion contains numerous wetlands and ponds and its forests are often dominated by western larch, Douglas-fir, or Engelmann spruce. The valley is much lower, drier, and warmer than the adjacent Salish Mountains (151) and Canadian Rockies (41). Thick Quaternary alluvial and glacial drift deposits are characteristic and nonintegrated drainage and hummocky areas occur. The climax vegetation is mapped as Douglas-fir and grand fir forests, and is unlike the foothills grassland of the Flathead Valley (15c) and Tobacco Plains (15d). In the Swan River Valley, gravelly and droughty soils support Douglas-fir or Engelmann spruce climax forests while moister, finer textured soils have Engelmann spruce or subalpine fir climax forests. Logging and rural residential activity are the common land uses. Ecoregion 15t extends into Canada.

valleys. Characteristically, it is underlain by the Cretaceous Idaho Batholith, and its surface

waters have very low alkalinity. The rocks of Ecoregion 16e are lithologically distinct from the

Precambrian argillite, quartzite, and argillaceous rocks that compose the nearby Grave Creek

Range-Nine Mile Divide (15a) and Rattlesnake-Blackfoot-South Swan-Northern Garnet-

Sapphire Mountains (17x). Alpine glaciers descended to an elevation of about 4,000 feet; till is

common and outwash deposits are found in lower mountain valleys north of Hamilton.

Maximum elevations exceed 9,500 feet and are greater than those of Ecoregions 15a, 16a, and

17x. The high Bitterroots receive some Pacific influence and act as a barrier to its eastward

continuation; Pacific air masses increase cloudiness and precipitation and moderate temperatures

somewhat. Average annual precipitation is about 16 to 70 inches, and maximums are much

greater than in the Eastern Batholith (16a) and Rattlesnake-Blackfoot-South Swan-Northern

Garnet-Sapphire Mountains (17x). The climax vegetation is mapped as subalpine fir, Douglas-

fir, and ponderosa pine forests, with Engelmann spruce also occurring; it is distinct from that of

Ecoregions 15p and 17ag. Ecoregion 16e is mostly wilderness, but some logging and grazing is

The wet, severely exposed, glaciated High Idaho Batholith contains jagged peaks, tarns, and

17. Middle Rockies (continued)

The **Bitterroot-Frenchtown Valley** ecoregion is sheltered from high winds and severe weather by surrounding mountains. It is composed of floodplains, terraces, hills, fans, wildlife-rich wetlands, and riparian forests. Thick alluvial and lacustrine deposits are common; moraines and glacial outwash also occur to the south and north, respectively, of Hamilton. Average annual precipitation is 12 to 24 inches; maximums exceed those of more easterly and southerly valleys such as in Ecoregions 17w, 17aa, and 17ak. Climax vegetation is mapped as foothill grasslands and floodplain hardwood forest. The Bitterroot River's course can be very unstable and small side channels, sloughs, and oxbow lakes are common. However, turbidity is generally low except during the very high stream flows that accompany spring snow melt and summer thunderstorms. Irrigated and nonirrigated agriculture is extensive and, in late summer, parts of the Bitterroot River can be nearly dewatered at major irrigation diversions. Urban, suburban, rural residential, and industrial development are other common land uses.

The Limy Foothill Savanna ecoregion lies east of the Continental Divide and slopes from the forested Big Snowy-Little Belt Carbonate Mountains (17q) to the grassy foothills and plains below. Characteristically, Ecoregion 17t is dissected by mountain-fed streams and is covered by a forest-grassland complex. It is underlain by Mesozoic and Paleozoic sedimentary rocks that are rich in carbonates unlike those of the Foothill Grassland (42r) and Montana Central Grasslands (43n). Elevations range from about 4,000 to 7,000 feet and lie between those of the lower, drier plains below and the higher, wetter mountains above. The Limy Foothill Savanna (17t) has more available moisture and, correspondingly, a different potential natural vegetation than the nearby Limy Foothill Grassland (43u). Grazing, gravel quarrying, and logging are the common land uses.

The **Paradise Valley** is an intermontane valley containing grasslands and meadows. It is mostly composed of Quaternary alluvium and Tertiary sedimentary rock; glacial drift deposits and Tertiary volcanics also occur. Potential natural vegetation is foothills prairie and is characterized by the predominance of fescues and wheatgrasses. Today, the Paradise Valley (17u) is used for rangeland, cropland, recreation, rural residential developments, and commercial activities.

The partially glaciated **Big Belt Forested Highlands** ecoregion lies to the east of the Continental Divide. The highest areas are composed of igneous intrusive rocks but, generally, Ecoregion 17v is underlain by Precambrian limestone and is lithologically distinct from the nearby Scattered Eastern Igneous-Core Mountains (17r), Elkhorn Mountains-Boulder Batholith (17ai), Eastern Divide Mountains (17aj), Mid-Elevation Sedimentary Mountains (17g), and Big Snowy-Little Belt Carbonate Mountains (17q). Climax vegetation is mapped as subalpine fir, Douglas-fir, and ponderosa pine forests and differs from that of Ecoregions 17g, 17w, 43t, and 43u. Grazing, logging, mining, and recreation are the most common land uses.

The broad, semiarid, largely treeless **Townsend Basin** lies east of the Continental Divide and contains floodplains, stream terraces, alluvial fans, and hills. It is mostly composed of Quaternary alluvium and Tertiary valley fill unlike the more rugged Townsend-Horseshoe-London Sedimentary Hills (17y), Dry Gneissic-Schistose-Volcanic Hills (17ab), Northern Rockies (15), and Middle Rockies (17). Elevations tend to be lower and the growing season longer than in the Shield-Smith Valleys (43t) or the surrounding mountains. Ecoregion 17w's climate is drier than the valleys west of the Continental Divide but wetter than the Dry Intermontane Sagebrush Valleys (17aa) to the southwest. Potential natural vegetation consists of foothills prairie and grama-needlegrass-wheatgrass; it differs from the forests of Ecoregions 15 and 17 and the sagebrush steppe of Ecoregions 17aa, 17ab, and 43t. Today, cropland, rangeland, and urban-suburban-industrial development occur.

The Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains ecoregion is forested and lies west of the Continental Divide. Ecoregion 17x is underlain primarily by a heterogeneous mixture of Precambrian Belt formations but Tertiary-Cretaceous igneous rocks also occur. Overall, it is lithologically distinct from the Eastern Pioneer Sedimentary Mountains (17ah), Southern Garnet Sedimentary-Volcanic Mountains (17al), and the mixed rock of the neighboring Flint Creek-Anaconda Mountains (17am). The climax vegetation is mapped as subalpine fir, Douglas-fir, and ponderosa pine forests and is distinct from Ecoregions 15a, 17aj, 17am, 17p, and 41. The forests of Ecoregion 17x tend to be drier than the ecoregions to the northwest and west but are wetter than those to the east of the Continental Divide. They are used for logging and recreation.

The partially wooded **Townsend-Horseshoe-London Sedimentary Hills** ecoregion lies in the rainshadow of the Elkhorn Mountains and is rather dry. It is largely composed of Mesozoic and Paleozoic sedimentary rock; limestone is common and both caverns and dry valleys occur. The Townsend-Horseshoe-London Sedimentary Hills (17v) ecoregion is lithologically distinct from the nearby Dry Gneissic-Schistose-Volcanic Hills (17ab) and related stream quality, surficial water availability, and aquatic biota are also different. Elevations range from about 4,000 to 8,200 feet and are intermediate between the higher, forested Northern Rockies (15) and the lower Townsend Basin (17w). Grazing, logging, and mining are the

The glaciated, forested Tobacco Root Mountains ecoregion is characterized by a Tertiary granitic core and is geographically isolated from neighboring mountainous ecoregions. Ecoregion 17z is steeper and more rugged than the Elkhorn Mountains-Boulder Batholith (17ai) and its core is lithologically distinct from the Gneissic-Schistose Forested Mountains (171). Average annual precipitation ranges from about 16 to 40 inches which is greater than for Ecoregion 17ai. The climax vegetation is mapped as subalpine fir and Douglasfir. Logging, grazing, mining, and recreation are the primary land uses.

The Dry Intermontane Sagebrush Valleys ecoregion is composed of alluvium, fan, and valley-fill deposits. Its stream terraces, floodplains, saline areas, and alluvial fans are less rugged then the adjacent Townsend-Horseshoe-London Sedimentary Hills (17y) and Dry Gneissic-Schistose-Volcanic Hills (17ab). Characteristically, the potential natural vegetation is sagebrush steppe and contrasts with the foothills prairie of the Townsend Basin (17w) and Deer Lodge-Philipsburg-Avon Grassy Intermontane Hills and Valleys (17ak) and the forests of the Northern Rockies (15) and Middle Rockies (17). The growing season ranges from 70 to 110 days and exceeds that of the Big Hole (17ac) and Centennial Basin (17af). Grazing is common and farming takes place especially on bottomlands; near Butte, mining, urban, and industrial activity are the prevalent landuses.

The semiarid shrubby **Dry Gneissic-Schistose-Volcanic Hills** ecoregion is characteristically underlain by Precambrian pre-Belt rocks and Tertiary volcanics. Elevations range from about 4,800 to 9,600 feet. Average annual precipitation is greater than immediately below in the Townsend Basin (17w), Dry Intermontane Sagebrush Valleys (17aa), and Centennial Basin (17af). The potential natural vegetation is mapped as mostly sagebrush steppe. Grazing, mining, and wildlife habitat are common land uses.

The cold, subirrigated **Big Hole** ecoregion is a low-relief, high elevation valley containing meadows, extensive wetlands, floodplains, swampy creeks, many springs, broad stream terraces, and alluvial fans. The growing season averages about 30 days, which is much shorter than those of the neighboring Deer Lodge-Philipsburg-Avon Grassy Intermontane Hills and Valleys (17ak) or the Dry Intermontane Sagebrush Valleys (17aa). The potential natural vegetation is mapped as mostly sagebrush steppe. Gravel quarries occur, ranches are common, and much of the valley is ditched.

Scale 1:2 833 300 1 inch represents 44.7 miles

16. Idaho Batholith

The **Eastern Batholith** ecoregion is forested and mountainous and lies northwest of the Continental Divide. Characteristically, Ecoregion 16a is underlain by intrusive rocks of the Cretaceous Idaho Batholith and, in consequence, its surface waters are very low in alkalinity. The Eastern Batholith (16a) ecoregion is lithologically distinct from the Precambrian Belt rocks of Ecoregion 17x and lacks the nearly parallel, ice-gouged valleys and numerous lakes and wetlands of the Glaciated Bitterroot Mountains and Canyons (16e). Average annual precipitation ranges from **16 to 55 inches**; maximums are less than those of Ecoregion 16e but more than those southeast of the Continental Divide in the Forested Beaverhead Mountains (17ae) or the Pioneer-Anaconda Ranges (17ag). The climax vegetation is subalpine fir, Douglasfir, and ponderosa pine and is different from that of the Forested Beaverhead Mountains (17ae) or Pioneer-Anaconda Ranges (17ag) which lack the mapped ponderosa pine element. Logging, grazing, mining, and recreation are common land uses.

The mountainous **Lochsa Uplands** ecoregion is dissected but not as deeply as Ecoregion 16c. It s underlain by granitic rocks and mantled by volcanic ash deposits that increase the fertility and water retention of upland soils. Grand fir and Douglas-fir are common, Engelmann spruce and subalpine fir grow at high elevations, and cedar–hemlock–pine forests occur on north-facing slopes and in canyons. Marine influence is less than to the north but greater than to the south. Logging and road building cause land slides and stream sedimentation.

The forested, north-south trending, Glaciated Bitterroot Mountains and Canyons ecoregion is composed of jagged peaks, lakes, wetlands, and distinctive ice-gouged

rockland. It is often snowcapped and annual precipitation is greater than in nearby, lower ecoregions. Soils are shallow, stony, and have a cryic temperature regime. Ecoregion 16h includes alpine areas, subalpine parkland, and very high, open, wind-blown forests composed mostly of nonmarketable subalpine fir and whitebark pine. Tundra, alpine grassland, subirrigated meadows, and wetlands are found

The forested Yellowstone Plateau ecoregion is characterized by subdued topography and contains lakes, springs, hot springs, wetlands, and hills. It is physiographically distinct from the mountainous level IV ecoregions of the surrounding Middle Rockies (17). Ecoregion 17j is composed of Quaternary alluvial fill deposits, terrace deposits, colluvium, and glacial drift. The climax vegetation of the Yellowstone Plateau (17j) is Douglas-fir forest.

The wet, glaciated **Granitic Subalpine Zone** ecoregion is forested and characterized by lake-studded terrain that is far less rugged than the surrounding Middle Rockies (17). Quaternary drift, colluvium, and talus are common. Ecoregion 17k is underlain by Precambrian pre-Belt rock and is lithologically distinct from the adjacent Absaroka-Gallatin Volcanic Mountains (17i). Climax vegetation is mapped as subalpine fir and Douglas-fir forests and is

mostly forested. Ecoregion 17l is characteristically underlain by Precambrian pre-Belt gneiss and schist and rock outcrops occur. Its streams are generally clearer and have lower concentrations of dissolved calcium and magnesium than those in the lithologically distinct Absaroka-Gallatin Volcanic Mountains (17i). Low stream flows occur during drought and freezing periods. Typically, there is only a short time lag between rainfall and runoff peak and, consequently, storm hydrographs are flashy. Average annual precipitation ranges from less than 20 to 100 inches; maximums are much greater than those of the Eastern Gravelly Mountains (17d) but less than those of the higher Alpine Zone (17h). The climax vegetation is mapped as subalpine fir and Douglas-fir forests. Recreation and logging are the common land uses in the Gneissic-Schistose Forested Mountains (17l) and some grazing also occurs.

The semiarid **Dry Mid-Elevation Sedimentary Mountains** ecoregion is partially forested and characteristically underlain by Paleozoic sedimentary rock, primarily limestone and dolomite. Average annual precipitation is much less than in the higher mountains to the west and ranges from less than 12 to just over 25 inches. The climax overstory vegetation is primarily mapped as Rocky Mountain juniper, limber pine, subalpine fir, Douglas-fir, and ponderosa pine forests. Large areas of both forest-grassland complex and foothills prairie also occur; much of the vegetation contrasts with that of the neighboring ecoregions. Grazing and

The Foothill Potholes ecoregion lies below glaciated mountain canyons and is composed of hills, hummocky moraines, outwash plains, terraces, and fans. Characteristically, it is covered by extensive Quaternary glacial drift and contains numerous, wildlife-rich, wetlands and pothole lakes. The potential natural vegetation is mapped as mostly foothills prairie. Shrub- and tree-covered, mountain-fed streams descend into Ecoregion 17p and both subirrigated and wetland areas also occur. Ecoregion 17p receives more precipitation than the plains below and less than the mountains above.

The forested **Big Snowy-Little Belt Carbonate Mountains** ecoregion lies east of the Rocky Mountain Front where the climate is drier and more continental than the more westerly parts of the Northern Rockies (15). Ecoregion 17q is characteristically underlain by Paleozoic and Mesozoic limestone, dolomite, sandstone, and shale. Generally, it is lithologically distinct from the Scattered Eastern Igneous-Core Mountains (17r), and related stream quality, surficial water availability, aquatic biota, and soils are also different. The climax vegetation is mapped as subalpine fir, Douglas-fir, and ponderosa pine forests in the western and central Little Belt Mountains and spruce and Douglas-fir forests in the Big Snowy Mountains and

The rather dry, mostly wooded **Scattered Eastern Igneous-Core Mountains** ecoregion lies east of the Rocky Mountain Front and is characteristically underlain by Tertiary volcanic and intrusive rocks. It is lithologically distinct from the Big Snowy-Little Belt Carbonate Mountains (17q), and related stream quality, surficial water availability, aquatic biota, and soils are also different. Average annual precipitation ranges from 16 to just over 30 inches. The climax vegetation is often Douglas-fir forest; ponderosa pine occurs at 4,000 to 6,000 feet elevation, subalpine fir at 6,500 to 7,000 feet, and forest-grassland complex is found

17. Middle Rockies (continued)

The Western Beaverhead Mountains ecoregion occupies the elevational band between the Alpine Zone (17h) and the lower, less rugged Ecoregion 17ab. It is underlain by quartzite and argillite; the lithologic mosaic and related slope stability and water quality issues are unlike those of Ecoregion 16k. Vegetation is affected by elevation and slope aspect. Mountain big sagebrush, mountain brush, and understory grasses grow on south-facing slopes and Douglas-fir, lodgepole pine, aspen, and subalpine fir occur on north-facing slopes. Land uses include grazing, mining, recreation, and logging.

The glaciated, **Forested Beaverhead Mountains** ecoregion is characterized by pothole lakes, drift deposits, boggy areas, and gentle lower slopes. Ecoregion 17ae is underlain by Precambrian argillite, quartzite, argillaceous rocks, carbonates, and shales. It is lithologically distinct from the carbonate-rich Barren Mountains (17e) as well as from ecoregions that are underlain by intrusive rocks, including the Eastern Batholith (16a) and Glaciated Bitterroot Mountains and Canyons (16e). Climax vegetation is mapped as subalpine fir and Douglas-fir forests. Ecoregion 17ae receives an average annual precipitation of 20 to just over 40 inches; maximums are much greater north of the Continental Divide in Ecoregion 16e where the climax vegetation is also different. Streams are typically low in turbidity except during high discharge events which accompany thunderstorms and spring snow melt. Grazing, mining, recreation, and logging are the principal land uses.

170f The very high and cold, low-relief Centennial Basin ecoregion is distinctively subirrigated. It contains grasslands, meadows, lakes, and extensive wetlands; sand plains, dunes, and lake deposits are common. Elevations range from more than 6,500 to 7,000 feet and the growing season is only about 50 days. Its aquic, cryic soils reflect its environment and are taxonomically distinct from those of the neighboring Dry Gneissic-Schistose-Volcanic Hills (17ab), Dry Intermontane Sagebrush Valleys (17aa), and Barren Mountains (17e). The mapped potential natural vegetation is sagebrush steppe. The Red Rock National Wildlife Refuge occurs in this ecoregion.

The Pioneer-Anaconda Ranges ecoregion is glaciated and forested. It lies southeast of the Continental Divide and contains glacial drift, many lakes, and wetlands. Ecoregion 17ag is underlain by sedimentary and metasedimentary rocks and is lithologically distinct from the igneous rocks that characterized the Idaho Batholith (16). Climax vegetation is mapped as subalpine fir and Douglas-fir forests and is distinct from that found on the opposite side of the Continental Divide in the wetter Eastern Batholith (16a). Average annual precipitation ranges from 16 to about 40 inches; maximums are more than in the Barren Mountains (17e) to the southwest. Land uses include logging, grazing, recreation, mining, wildlife habitat, watershed,

17ah The rather dry Eastern Pioneer Sedimentary Mountains ecoregion lies south of the Continental Divide and is mostly forested. It is already to be a south of the continental Divide and is mostly forested. Continental Divide and is mostly forested. It is characterized by Paleozoic and Mesozoic sedimentary rocks and is lithologically distinct from the intrusive and extrusive rocks of the neighboring Elkhorn Mountains-Boulder Batholith (17ai). Limestone is common and strongly affects water quality, available water quantity, soils, and aquatic biota. Granitic intrusions occur and have locally reacted with limestone to produce zones of skarn that have been mined for the tungsten mineral scheelite. Average annual precipitation ranges from 12 to 20 inches. The Eastern Pioneer Sedimentary Mountains (17ah) ecoregion was glaciated but has fewer lakes than the Pioneer-Anaconda Ranges (17ag) ecoregion which is wetter and more westerly. Climax vegetation is mapped as subalpine fir and Douglas-fir forests.

The mostly forested Elkhorn Mountains-Boulder Batholith ecoregion straddles the Continental Divide and is underlain by Cretaceous and Tertiary intrusive and extrusive

rocks; areas of unique boulder-strewn topography occur and are composed of erosion-prone andesitic rocks. Ecoregion 17ai is lithologically distinct from the neighboring Precambrian Belt rocks of the Eastern Divide Mountains (17aj) and the Southern Garnet Sedimentary-Volcanic Mountains (17al). Both mining and related environmental impacts are common and most of the major known deposits of copper, zinc, lead, silver, and gold in Montana are associated with the Boulder Batholith. Annual precipitation is much less than in the mountains to the northwest and averages 12 to 30 inches. The mapped climax vegetation is subalpine fir and Douglas-fir forests and is distinct from the Douglas-fir and ponderosa pine forests of the neighboring Eastern Divide Mountains (17aj) and the treeless Townsend Basin (17w) and Deer Lodge-Phillipsburg-Avon Grassy Intermontane Hills and Valleys (17ak). Logging, mining, and recreation are the

The semiarid to subhumid, largely forested Eastern Divide Mountains ecoregion is underlain by Precambrian Belt formations and is lithologically distinct from the Big Snowy-Little Belt Carbonate Mountains (17q), Scattered Eastern Igneous-Core Mountains (17r), Elkhorn Mountains-Boulder Batholith (17ai), and Southern Garnet Sedimentary-Volcanic Mountains (17al). Ecoregion 17aj lies east of the Continental Divide where it receives 12 to 25 inches of precipitation per year, less than farther west. The climax vegetation is mapped as Douglas-fir and ponderosa pine forests, with subalpine fir occurring at the highest elevations; it is distinct from the nearby, treeless Ecoregions 42r, 42q, and 43u.

The Deer Lodge-Philipsburg-Avon Grassy Intermontane Hills and Valleys ecoregion lies west of the Continental Divide and is composed of stream terraces, foothills, and floodplains. Ecoregion 17ak is farmed, grazed, and used for urban, suburban, and industrial activity. Ecoregion 17ak includes the settling ponds near the Anaconda smelter site and a downstream section of the Clark Fork that has high concentrations of heavy metals. The climate is wetter than the Dry Intermontane Sagebrush Valleys (17aa) to the south, drier than the Bitterroot-Frenchtown Valley (17s), and less continental than the Townsend Basin (17w) to the east. The potential natural vegetation is mapped as foothills prairie and is distinct from the forests of the nearby Northern Rockies (15) and the sagebrush steppe of the Big Hole (17ac) and Dry Intermontane Sagebrush Valleys (17aa).

The forested Southern Garnet Sedimentary-Volcanic Mountains ecoregion lies to the west of the Continental Divide. It is characteristically underlain by carbonate-rich Mesozoic and Paleozoic sedimentary formations which are locally intruded by granitic rocks. Generally, the lithology of Ecoregion 17al is different from that of nearby ecoregions which are primarily underlain by igneous or metamorphic rocks; related stream quality, surficial water availability, aquatic biota, and soils are also different. Climax vegetation is mapped as Douglasfir and ponderosa pine forests and is distinct from the subalpine fir and Douglas-fir forests of the higher Flint Creek-Anaconda Mountains (17am). Logging, mining, and recreation are the

The forested Flint Creek-Anaconda Mountains ecoregion lies west of the Continental Divide and is underlain primarily by Tertiary igneous rocks and Mesozoic sedimentary rocks in contrast to neighboring Ecoregion 17x that is dominated by Precambrian Belt rocks. Characteristically, it was glaciated and both drift and lakes are much more common than in Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x), the Elkhorn Mountains-Boulder Batholith (17ai), or the Southern Garnet Sedimentary-Volcanic Mountains (17al). The climax vegetation is mapped as subalpine fir and Douglas-fir forests and is distinct from the Douglas-fir and ponderosa pine forests of nearby Ecoregion 17al. Logging, grazing, mining, recreation, wildlife habitat, watershed, and rural residential development are the primary land uses. Airborne smelter pollution has affected the condition of the vegetation.

18. Wyoming Basin

The **Bighorn Basin** lies in the rainshadow of the Beartooth Plateau. It includes some of the driest places in Montana, and parts receive an average of only six inches of precipitation per year. Unleached, nearly white soils commonly occur. These were derived from the underlying Quaternary terrace deposits, Tertiary Fort Union Formation, and Cretaceous

sedimentary rock and are often alkaline and/or gypsiferous. The potential natural vegetation is mostly sagebrush steppe and is distinct from that of the surrounding ecoregions. Most land is used for grazing but some irrigated agriculture occurs, especially near the Yellowstone River.

41. Canadian Rockies

The Northern Front is a rugged, forested, mountainous ecoregion lying east of the Continental Divide. Its climate is more continentally influenced than the Western Canadian Rockies (41c). Groundwater levels are extremely variable but are typically deeper than west of the Continental Divide. The ecoregion was glaciated, and drift deposits, colluvium, hummocky morainal areas, U-shaped valleys, pothole lakes-wetlands, and poorly developed drainage networks are common. Outcrops of Precambrian Belt rock occur and are distinctly different from those of the Southern Carbonate Front (41d). Climax vegetation is subalpine fir and Douglas-fir forests and differs from that of the neighboring Foothill Grassland (42r), Rocky Mountain Front Foothill Potholes (42q), Crestal Alpine-Subalpine Zone (41b), and Western Canadian Rockies (41c). The eastern boundary of Ecoregion 41a coincides with lower timberline and ranges from 4,500 to 5,000 feet elevation. Ecoregion 41a extends into Canada.

The Crestal Alpine-Subalpine Zone ecoregion includes the highest parts of the rugged Canadian Rockies. Maximum elevations are sufficiently high to trap Pacific moisture and exceed 10,400 feet. Ecoregion 41b is characterized and differentiated from lower areas by its heavy precipitation, active glaciers, thick winter snow pack, very short growing season, numerous tarns, and mixed high elevation climax vegetation. It is similar to the High Northern Rockies (15h), the High Idaho Batholith (16h), and the Alpine Zone (17h) that occur in different level III ecoregions. A variety of rock underlies the ecoregion, and colluvium, talus, and rock outcrops are common. Ecoregion 41b extends into Canada.

The high, rugged, glaciated Western Canadian Rockies ecoregion lies west of the Continental Divide and is affected by moist Pacific maritime air masses. Precipitation significantly exceeds that of the rainshadow area on the eastern slopes and groundwater levels are typically closer to the surface. Groundwater recharge rates are slow where the terrain is steep and the permeability of the bedrock is low. The climax vegetation of Ecoregion 41c is subalpine fir, Douglas-fir, grand fir, and Engelmann spruce forests and contrasts with that of the

higher Crestal Alpine-Subalpine Zone (41b) and the drier Northern Front (41a) and Southern Carbonate Front (41d). The Western Canadian Rockies (41c) is commonly mantled by volcanic ash, glacial drift, and colluvium. It is underlain by Precambrian rocks including argillites and quartzites and is lithologically distinct from the Southern Carbonate Front (41d) and Flathead Thrust Faulted Carbonate-Rich Mountains (41e). Ecoregion 41c extends into Canada.

The **Southern Carbonate Front** ecoregion lies east of the Continental Divide and has a more continental climate than ecoregions to the west. Characteristically, its glaciated mountains are often covered by drift or colluvium. Ecoregion 41d is underlain by Mesozoic-Paleozoic limestone and dolomite which is absent from the neighboring Eastern Divide Mountains (17aj), Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x), and Northern Front (41a); water quality, available water quantity, soils, vegetation, and aquatic biota also differ. The climax vegetation is mapped as mostly subalpine fir and Douglasfir forests and is distinct from that found west of the Continental Divide in the Eastern Divide Mountains (17aj), the Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x), the Crestal Alpine-Subalpine Zone (41b), and the Flathead Thrust Faulted Carbonate-Rich Mountains (41e).

The high, wet, glaciated Flathead Thrust Faulted Carbonate-Rich Mountains ecoregion lies west of the Continental Divide where maritime influences, including average annual maximum precipitation, are greater than to the east. The ecoregion is characteristically, but not wholly, underlain by Paleozoic limestones, sandstones, and quartzites. Its carbonate-rich rocks significantly influence water quality, available water quantity, soils, vegetation, and aquatic biota and help to differentiate the ecoregion from the neighboring Western Canadian Rockies (41c) and the Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x). Glacial drift, colluvium, and volcanic ash are common.

42. Northwestern Glaciated Plains

The Collapsed Glacial Outwash ecoregion is an irregular, treeless plain composed of gravel and sand. Its deposits differ from the till, alluvium, terrace material, and loess of the neighboring Glaciated Dark Brown Prairie (42i). The outwash material of Ecoregion 42b was originally deposited by glacial meltwater and precipitation runoff over stagnant ice; it later collapsed in on itself to form Ecoregion 42b's irregular topography. Groundwater is shallow and plentiful. Many more wildlife-rich ponds, wetlands, and large, shallow lakes occur in Ecoregion 42b than in Ecoregion 42i; they tend to be slightly to very alkaline depending upon the flow path of groundwater through the permeable outwash. Ecoregion 42b and its wildlife refuges attract birds that prefer large areas of open water, such as white pelicans, black terns, and Forster's terns, as well as those living in brackish water, such as avocets and tundra swans. The Collapsed Glacial Outwash (42b) ecoregion extends into North Dakota.

The Northern Missouri Coteau ecoregion is a very hummocky, lake-studded, stagnation moraine with non-integrated drainage and many wetlands; its surficial deposits and/or physiography distinguish it from nearby ecoregions. Ecoregion 42d lies in a transition zone between a more boreal climate to the north and a more arid climate to the west. Willow and aspen, southern outliers of aspen parkland to the north, may grow along wetland margins. Rough fescue, also a northern species, appears in grassland associations. Major land uses within the ecoregion are mixed dryland farming and grazing. The Northern Missouri Coteau (42d) extends into North Dakota and Canada.

The Glaciated Dark Brown Prairie ecoregion is primarily a treeless rolling till plain punctuated by scattered low-relief gravel benches. The ecoregion is characterized by dark brown till-derived soils, a potential natural vegetation of wheatgrass - needlegrass, and a land use mosaic of cropland and rangeland. To the west in the Glaciated Northern Grasslands (42j), drier conditions create lighter colored soils and, correspondingly, different natural vegetation. The Glaciated Dark Brown Prairie (42i) extends into North Dakota.

The Glaciated Northern Grasslands ecoregion is a dissected plain. Its brown, till-derived soils support a potential natural vegetation of grama - needlegrass - wheatgrass; they contrast with the dark brown soils of the Glaciated Dark Brown Prairie (42i) which support wheatgrass - needlegrass. Ecoregion 42j is dominated by rangeland but agriculture does occur on scattered, undissected gravel benches and on the alluvial, largely irrigated soils of the Milk River Valley. The Glaciated Northern Grasslands (42j) lies to the east of the extensive cash grain farms of the less dissected, North Central Brown Glaciated Plains (420); it lies to the west of the cropland-rangeland of the less dissected, Glaciated Dark Brown Prairie (42i).

The Coteau Lakes Upland ecoregion is a treeless, morainal area with lakes, ponds, and wetlands and largely internal drainage. Its terrain is more irregular than the Glaciated Dark Brown Prairie (42i) and less hummocky than the lake-studded Northern Missouri Coteau (42d). The loamy, sandy, or gravelly soils of Ecoregion 42k were derived from the underlying glacial drift. Shortgrass prairie vegetation is native and is now commonly interspersed with cropland; shrubs are restricted to the moist depressional areas. Hilly areas are grazed but elsewhere wheat, barley, oats, and hay farming is common. Ecoregion 42k extends into Canada.

The grassy **Sweetgrass Uplands** ecoregion is a rolling to hummocky, end moraine area that has many seasonal pothole lakes and impoundments. It is physiographically distinct from the surrounding foothills and rolling plains and extends into Canada. Potential natural vegetation is grama-needlegrass - wheatgrass and grazing is the common land use.

The undulating to strongly sloping Cherry Patch Moraines ecoregion has many seasonal lakes and wetlands and includes one of the most extensive and prominent end moraines in Montana. It extends into Canada. Shortgrass prairie vegetation is native and shrubs are restricted to moist depressions. Steep slopes, hummocky moraines, gullies, bouldery knolls, gravelly ridges, and coulees are often grazed. Extensive cereal farming occurs elsewhere. Brown

The Milk River Pothole Upland ecoregion is a terminal moraine area characterized by numerous potholes and nonintegrated drainage. Its hummocky physiography is distinct from the largely undissected till plains and nearly level lake plains of Ecoregion 42o. Land use is a mosaic of rangeland, farmland, and oil wells. Ecoregion 42n extends into Canada.

The treeless North Central Brown Glaciated Plains ecoregion is an important grain producing area. Land use contrasts with the rangeland of Ecoregions (42j) and (42r). Its very broad, largely undissected till plains and nearly level, poorly-drained, proglacial lake plains are chinook-affected. The potential natural vegetation is grama - needlegrass - wheatgrass and is distinct from the foothills prairie community found in the adjacent but more sloping Ecoregion 16a. Soils are brown and were derived from glacial drift, glaciolacustrine, and alluvial deposits. Oil wells are common locally. Ecoregion 42o continues into Canada.

The Rocky Mountain Front Foothill Potholes (42q) ecoregion lies below glaciated mountain canyons and is composed of hills, hummocky moraines, outwash plains, terraces, and fans. It is covered by extensive Quaternary glacial drift and contains many wildliferich wetlands and pothole lakes. The potential natural vegetation is mapped as mostly foothills prairie. Shrub- and tree-covered, mountain-fed streams descend into Ecoregion 43q and both subirrigated and wetland areas also occur. Ecoregion 43q receives more precipitation than the plains below and less than the mountains above. Chinook frequency exceeds 200 per century. Grazing, gravel quarries, and recreation occur and ranches are common.

The Non-calcareous Foothill Grassland ecoregion lies east of the Continental Divide where it slopes down from the lower mountain treeline to the plains. Its hills and scattered buttes are dissected by shrub- and tree-covered, mountain-fed streams. Ecoregion 42r is physiographically different from the mountains of Ecoregions 17 and 41, the plains of ecoregions 42 and 43, and the Rocky Mountain Front Foothill Potholes (42q). Potential natural vegetation is mostly foothills prairie. A variety of mostly non-carbonate rocks underlie Ecoregion 42r; lithology, stream quality, and aquatic biota are different than in the Limy Foothill Grassland (43u). Ecoregion 42r typically receives more precipitation than the plains below and less than the mountains above. It can be affected by chinooks. Ranching is common. Ecoregion 42r extends into Canada.

43. Northwestern Great Plains

The treeless, rolling hills and benches of the Missouri Plateau ecoregion were mostly unmodified by continental glaciation. Ecoregion 43a is underlain by the Tertiary Fort Union Formation and Flaxville Gravels. Its soils were derived from residuum and are not so naturally fertile as the till-based soils of the Northwestern Glaciated Plains (42). The potential natural vegetation of the Missouri Plateau (43a) is wheatgrass-needlegrass and contrasts with the grama-needlegrass-wheatgrass that occurs farther west on the more aridic soils of the Montana Central Grasslands (43n). Land use is a mosaic of both rangeland and farmland while, in contrast, the neighboring Montana Central Grasslands (43n) and River Breaks (43c) are dominated by rangeland. Parts of Ecoregion 43a are subject to wind erosion when overgrazed. The Missouri Plateau (43a) extends eastward into the Dakotas.

The Little Missouri Badlands ecoregion is highly dissected, sparsely vegetated, and lies within the watershed of the Little Missouri River. Ephemeral, flashy stream flow is typical and has created steep, downcut channels. Both erosion rates and drainage densities are high, and as a result, streams carry heavy sediment loads. Fine-grained, sedimentary rock of the Tertiary Fort Union and the Cretaceous Hell Creek formations outcrop on steep slopes. Vegetation is typically sparse shortgrass prairie; clumps of Rocky Mountain juniper grow on north-facing hillslopes while Northern Floodplain forest grows along drainage ways. Physiography, soils, and land use are distinct from those of the Missouri Plateau (43a), Sagebrush Steppe (43e), and Montana Central Grasslands (43n). The dissected topography, wooded draws, and uncultivated areas of the Little Missouri Badlands (43b) are havens for wildlife. Grazing and recreation are the dominant land uses. The Little Missouri Badlands (43b) ecoregion extends into the Dakotas.

The **River Breaks** ecoregion is composed of very highly dissected terraces and uplands that descend to the Missouri and Yellowstone river systems. Ecoregion 43c is much more rugged than surrounding ecoregions; its steep slopes and heavy, sticky soils often limit its suitability for spring pasture while scarcity of stock water constrains its use for summer grazing. Sparse wheatgrass grows on the heavy, slowly permeable bottomland, threadleaf sedge and needleandthread occur on the gravelly soils of hillslopes, junipers and deciduous trees grow on north-facing slopes of draws, and both little bluestem and buffalograss are found along flatbottomed channels. The ecoregion's dissected topography, wooded draws, and uncultivated areas are havens for wildlife. The River Breaks (43c) ecoregion continues into North Dakota.

The Forested Buttes ecoregion is underlain by resistant, often concretionary Tertiary sediments. It locally stands 500 to 850 feet above the surrounding, largely treeless plains of the Sagebrush Steppe (43e) and Montana Central Grasslands (43n). The ecoregion's mesas and eroded knobs commonly have sufficient elevation, microtopography, and spring seepage to increase available moisture enough to promote tree growth. Ponderosa pine forests and savanna are common; green ash, boxelder, snowberry, and upland juniper grow in the draws; and toeslopes are grassy. Ecoregion 43d is less grazed than adjacent ecoregions. The Forested Buttes (43d) ecoregion is also found in South Dakota.

The **Sagebrush Steppe** ecoregion is nearly level to rolling and is locally surmounted by eroded buttes. Heavy, alkali-rich, slowly permeable, erosion-prone soils are common and support a sparse cover of shortgrass prairie, big sagebrush, and Nuttall saltbush. Grazing is the common land use, but livestock carrying capacity is rather low compared to other Montana rangelands. Much of the area has been severely overgrazed, resulting in erosion. The region has low human population, minimal cultivation, and relatively high concentrations of wildlife. Compared with other nearby ecoregions, Ecoregion 43e has much less dryland farming than the Missouri Plateau (43a), is less dissected than either the River Breaks (43c) or the Montana Central Grasslands (43n), has different potential natural vegetation than the Pine Scoria Hills (43p) or the Montana Central Grasslands (43n), and generally lacks the mesic soils of the Semiarid Pierre Shale Plains (43g) or the Dense Clay Prairie (43k). Ecoregion 43e is also found in the Dakotas.

The treeless, rolling **Semiarid Pierre Shale Plains** ecoregion is characterized by heavy, mesic soils derived from underlying Cretaceous sedimentary rock. Mesic soils are rare in Montana and contrast with frigid soils farther north in the Northwestern Great Plains (43). The potential natural vegetation is mapped as wheatgrass-needlegrass and grazing is the predominant land use. The Semiarid Pierre Shale Plains (43g) ecoregion extends into South

The rolling **Dense Clay Prairie** is characterized by heavy, erosion-prone, mesic soils derived from the Cretaceous Pierre Formation. Mesic soils are rare in Montana and contrast with the frigid soils that occur farther north in the Northwestern Great Plains (43). Grazing is the major land use and sheep are common. The vegetative cover is sparse and even riparian woodland is absent from the draws and stream corridors. Careful management is required to avoid erosion and blowing soil. Ecoregion 43k extends into South Dakota.

The Missouri Breaks Woodland-Scrubland ecoregion has very highly dissected topography and erodible clayey soils derived from Cretaceous sedimentary rock. Steep, rugged terrain with a climax vegetation of ponderosa pine and Rocky Mountain juniper woodland, grassland, and scrubland are characteristic and distinguish the ecoregion from the River Breaks (43c), Glaciated Northern Grasslands (42j), Judith Basin Grassland (43m), and Montana Central Grasslands (43n). Ecoregion 43l is lightly and locally grazed, since stock watering facilities are rare. Some farmland is irrigated especially near the Missouri River. The dissected topography, wooded slopes and draws, and uncultivated areas of Ecoregion 431 are havens for wildlife.

The benches, alluvial fans, plains, and foothills of the Judith Basin Grassland ecoregion are commonly composed of Quaternary terrace deposits that are much more extensive than in the surrounding ecoregions. Land use is a mosaic of farmland and rangeland; better quality, undissected land is devoted to grain production and is very fertile. In contrast, the neighboring Montana Central Grasslands (43n) and Foothill Grassland (42r) are dominated by rangeland. Precipitation, soil productivity, grass density, and carrying capacity vary and become lower to the south of the Big and Little Snowy mountains. Soils can be gravelly.

The Central Grassland ecoregion is an unglaciated plain that is dissected by many small, ephemeral or intermittent streams. It is largely underlain by noncarbonate, finegrained sedimentary rock of the Tertiary Fort Union Formation which become less widespread in the neighboring, but less dissected, Ecoregion 43e. Clayey frigid soils derived from residuum are common and have a ustic-aridic moisture regime; they contrast with the mesic soils of Ecoregion 43q and the less aridic soils of Ecoregion 43a. Potential natural vegetation is gramaneedlegrass-wheatgrass and is distinct from that of the Sagebrush Steppe (43e) and Pine Scoria Hills (43p). Ecoregion 43n is mostly rangeland but irrigated and unirrigated farms occur in the Yellowstone Valley. Overall, farm land is less common than in the Judith Basin Grassland

The Unglaciated Montana High Plains ecoregion is composed of treeless plains and hills. Internally-drained basins and deflation hollows locally occur and contain wildliferich wetlands and lakes. Elevations exceed 3,600 feet and rangeland is the most common land use; however, dryland farming occurs and is, on the whole, more common than in the Montana Central Grasslands (43n). Strong winds occur and are a significant erosion threat. Ecoregion 43o is underlain by Tertiary and Cretaceous shale, siltstone, and sandstone. Its soils are derived from residuum and support a potential natural vegetation of grama-needlegrass-wheatgrass.

The **Pine Scoria Hills** ecoregion is characterized by wooded, rugged, broken land and stony hills. Alluvium and rocky, gravelly colluvium are common. Soils are often poorly developed. In high areas, open ponderosa pine-Rocky Mountain juniper forests grow and have a heavy understory of grasses while, in drier areas, ponderosa pine savanna is found. Stock carrying capacity is low due to rough terrain and lack of water.

The treeless, unglaciated **Mesic Dissected Plains** ecoregion is underlain by shales and sandstones of the Tertiary Fort Union Tongue River Member as well as massive sandstones and shales of the Tertiary Wasatch Formation; the Wasatch Formation is rare elsewhere in Montana. Clinker beds, porcelinite, coal, scoria, and bedrock outcrops occur. Its mesic soils developed from residuum and contrast with the frigid soils farther north in the Northwestern Great Plains (43). The potential natural vegetation is grama - needlegrass wheatgrass; it differs from the ponderosa pine forest and savanna of Ecoregion 43p and the wheatgrass - needlegrass of the Semiarid Pierre Shale Plains (43g) and Dense Clay Prairie (43k). Today, Ecoregion 43q is mostly used for grazing.

The Non-calcareous Foothill Grassland ecoregion slopes down from the lower mountain treeline to the plains. Its hills and scattered buttes are dissected by shrub- and tree-covered, mountain-fed streams. Ecoregion 43s is physiographically different from the mountains of Ecoregion 17 and the plains of Ecoregions 43. Potential natural vegetation is mostly foothills prairie and contrasts with the sagebrush steppe of the Dry Gneissic-Schistose-Volcanic Hills (17ab). A variety of mostly non-carbonate rocks underlie Ecoregion 43s; lithology, stream quality, and aquatic biota are different than in the Limy Foothill Grassland (43u) and the carbonate-rich Pryor-Big Horn Foothills (43v). Ecoregion 43s typically receives more precipitation than the plains below and less than the mountains above. It can be affected by chinooks. Ranching is common.

The broad, mostly treeless **Shield-Smith Valleys** ecoregion lies east of the Continental Divide. It is mostly underlain by Tertiary sediments and late-Cretaceous water-laid volcanics which are unlike the carbonate-rich, Mesozoic-Paleozoic sedimentary rocks of the Limy Foothill Grassland (43u). Stream quality and aquatic biota are also distinct from those of Ecoregion 43u. Potential natural vegetation consists of sagebrush steppe and foothills prairie; it contrasts with the foothills prairie and grama-needlegrass-wheatgrass of the Townsend Basin (17w). Currently, the area is mostly grazed in contrast to the nearby but lower Ecoregion 17w which has a mix of farming, grazing, and urban-suburban-industrial land uses.

The **Limy Foothill Grassland** ecoregion lies east of the Continental Divide. It slopes down from the lower treeline of the Little Belt and Big Snowy mountains to the gentler plains below and is dissected by perennial mountain-fed, shrub and tree covered streams. Characteristically, it is underlain by Mesozoic and Paleozoic sedimentary rocks that are often carbonate rich unlike the sedimentary and volcanic rocks of the Shield-Smith Valleys (43t) and Foothill Grassland (42r). Stream quality, surficial water availability, aquatic biota, and soils are also distinct. Elevations range from about 4,000 to 7,800 feet and are intermediate between those of the drier plains below and the wetter mountains above. Its sloping, hilly terrain has rather shallow soils that support a potential natural vegetation of foothills prairie. Grazing is the

The semiarid, largely treeless **Pryor-Big Horn Foothills** ecoregion slopes down from the lower mountain treeline to the Montana Central Grasslands (43n). It is typically underlain by carbonate-rich sediments and contains dissected benches and foothills. Many streams originate in the carbonate-rich Dry Mid-Elevation Sedimentary Mountains (43v); their water quality and aquatic biota contrast with that of the Foothill Grassland (42r). Potential natural vegetation is mapped as mostly foothills prairie and is distinct from the forests of the neighboring mountains and the grama-needlegrass-wheatgrass of the nearby plains. Elevations range from about 3,200 to 6,600 feet and are intermediate between those of the drier plains

below and the wetter mountains above. Grazing occurs and ranches are common.

common land use in Ecoregion 43u.

17. Middle Rockies

The glaciated Eastern Gravelly Mountains ecoregion has subdued, pothole-studded terrain and is mostly forested. Climax vegetation is mapped as subalpine fir and Douglas-fir forests. Barrens occur; they are more extensive than in the wetter Absaroka, Madison, and Gallatin ranges to the east but less widespread than in the Barren Mountains (17e). Ecoregion 17d is underlain by a variety of rocks. Its core consists of folded and faulted, generally carbonate-rich, Mesozoic and Paleozoic sedimentary rocks whereas lower slopes are underlain by Precambrian pre-Belt metamorphic and metasedimentary rocks and Tertiary rhyolite. Grazing and logging are the common land uses.

17e The partially forested, Barren Mountains ecoregion is commonly underlain by carbonate-rich sedimentary rocks. Elevations range from about 5,600 to just over 11,100 feet but only a few areas were glaciated. High, forested peaks are mainly composed of carbonate-rich Mesozoic and Paleozoic sedimentary rocks and Tertiary volcanics. Lower, less forested areas tend to be underlain by Precambrian rock. Ecoregion 17e is generally drier than nearby mountainous ecoregions and its lower elevations are characteristically semiarid. Climax vegetation is mapped as subalpine fir and Douglas-fir forests; Pacific Coast forest elements are absent and barrens are much more common than in nearby mountainous ecoregions. The forested belt is often very limited; lower treeline elevation occurs somewhere between 5,600 and 7,000 feet. Forest stands commonly have an undergrowth of grass, which can be sparse due to the semiarid conditions. Grazing, logging, mining, and recreation are the primary land uses.

The rugged, forested, glaciated Crazy Mountains ecoregion is geologically distinct from surrounding mountainous accrecions. Its core is accreciated from surrounding mountainous accrecions. from surrounding mountainous ecoregions. Its core is composed of Tertiary coarsegrained intrusive rocks and both dikes and sills radiate from it; away from the core, late-Cretaceous water-laid volcanics of the Livingston Formation are common. Average annual precipitation ranges from 16 to just over 50 inches; maximums are greater than in the mountainous ecoregions to the north and less than in the ranges to the south. The climax vegetation is mapped as subalpine fir and Douglas-fir forests. Logging is the major land use.

The carbonate-rich Mid-Elevation Sedimentary Mountains ecoregion is mostly forested and partially glaciated. It is lithologically distinct and less rugged than the neighboring Gneissic-Schistose Forested Mountains (171) and Absaroka-Gallatin Volcanic Mountains (17i). Ecoregion 17g is characteristically underlain by faulted and folded Mesozoic and Paleozoic sedimentary rocks, including limestone. Stream quality, surficial water availability, and aquatic biota are also different. Average annual precipitation ranges from less than 20 to just over 40 inches. Climax vegetation is mapped as subalpine fir and Douglas-fir forests. Logging, grazing, mining, and recreation are the common land uses.

The high, wet, severely exposed **Alpine Zone** ecoregion was glaciated and is characterized by jagged peaks, mixed high altitude vegetation, many tarns, rockland, and talus deposits. It is similar to the High Northern Rockies (15h), High Idaho Batholith (16h) and the Crestal Alpine-Subalpine Zone (41b) that occur in different level III ecoregions. Elevations range from about 8,500 to just over 12,500 feet. Average annual precipitation ranges from 30 to 100 inches and exceeds that of surrounding, but lower, ecoregions. Ecoregion 17h is often snowcapped for most of the year; permafrost occurs sporadically and solifluction has created patterned-ground in the alpine areas of the Beartooth Plateau. The soils are Udic, Cryic, Inceptisols and are typically very gravelly to stony. They support subalpine fir and whitebark pine forests in glacial cirques. Above timberline, alpine tundra, alpine grassland, subirrigated meadows, and wetlands occur. Krummholz vegetation occupies windswept areas between the forest and higher alpine areas.

17i The high, forested, partially glaciated Absaroka-Gallatin Volcanic Mountains ecoregion has rock outcrops, volcanic mud flows, and extensive glacial drift and colluvial deposits. Ecoregion 17i is underlain primarily by pyroclastic material, Tertiary volcanic flows, and water-laid volcanics; it is lithologically distinct from the Mid-Elevation Sedimentary Mountains (17g) and Gneissic-Schistose Forested Mountains (17l). Its air-fall volcanics readily weather to clay and tend to muddy the streams of Ecoregion 17i making them more turbid than those of Ecoregion 17l. Percolation rates are high and water tables are commonly perched, especially in unglaciated areas. Storm hydrographs show considerably greater lag time between rainfall and runoff than in the Gneissic-Schistose Forested Mountains (171). Springs and wetlands are common. Climax vegetation is mapped as subalpine fir and Douglas-fir forests; it differs from that of the higher Alpine Zone (17h). Recreation, grazing, logging, and mining are common land uses.

Recreation activity, mining, grazing, and logging are common land uses.

The rugged, glaciated Gneissic-Schistose Forested Mountains ecoregion is wet and

easternmost Little Belt Mountains. Logging, mining, and recreation are the principal land uses.